Amendment Under 37 CFR 1.116
Dated December 12, 2003
Serial No. 09/697,198

REMARKS

Reconsideration of the application, as amended, is respectfully requested. All objections and rejections are respectfully traversed.

By this amendment, claims 1, 2, 5, and 6 have been amended and claims 3 and 4 have been cancelled. Currently, claims 1, 2, 5, and 6 are pending in this application.

Rejection of the claims under 35 U.S.C. 103

Claims 1, 2, 5, and 6 were rejected under 35 U.S.C. 103 as unpatentable over Munks et al. (U.S. Patent No. 6,289,028) in view of Kobayashi (U.S. Patent No. 6,014,400). Additionally, claims 3 and 4 were rejected under 35 U.S.C. 103 as unpatentable over Munks in view of Kobayashi, and further in view of Mooradian (U.S. Patent No. 5,265,116) and Camparo (U.S. Patent No. 5,657,340). Claims 1, 5, and 6 have been amended to include the features formerly set forth in claims 3 and 4. All of these rejections are respectfully traversed in view of the amendments to the claims and the following arguments.

Independent Claim 1:

The present application describes a system that stabilizes a mechanically tuned semiconductor laser in the presence of vibrational problems. These vibrational problems can be caused by a variety of factors such as thermal noise, shot noise in the injection current, or noise in the laser tuning voltage. See page 4 lines 13-21. Although the effects of the vibrational problems may be small, e.g., a 300 MHz shift in the lasing frequency due to a 100 MHz vibration frequency, in some situations such as wave division multiplexing even such modest shifts in the lasing frequency can cause significant problems. See page 5, lines 6-11.

The configuration claimed in amended claim 1 provides for an indirect control of the wavelength of the output laser signal by measuring the wavelength of the output laser signal of

the optically-pumped tuned laser and controlling the pump laser to affect the wavelength of the optically-pumped tuned laser. Applicant respectfully submits that the indirect control methodology claimed in claim 1 is not taught or suggested by Munks and that the other cited art, i.e., Kobayashi, Mooradian, and Camparo, fails to make up for the deficiencies of Munks.

Munks teaches a system for measuring the wavelength of a laser signal emitted from a laser and controlling the laser using a feedback control system to maintain the laser signal at a constant wavelength. See Munks Abstract. In particular, the wavelength feedback control system of Munks measures the wavelength of the laser signal emitted from the laser, compares the measured wavelength to a desired wavelength, provides an error signal indicative of the difference between the measured and desired wavelengths, and using a feedback control algorithm adjusts either the temperature or the excitation current of the laser to bring the wavelength of the laser output signal to the desired wavelength. See Munks, col. 6, lines 4-22. Thus, Munks teaches a direct control system in which the laser that emits the laser output signal is the laser that is directly coupled to, and receives the control signal from, the laser controller.

As pointed out in the Office Action dated October 16, 2003, Munks fails to teach a tunable laser that has top and bottom electrodes, an optically pumped tuned laser system, and moreover, fails to teach controlling the optically pumped tuned laser by adjusting the intensity of the pump laser signal emitted by the pump laser. Because of the deficiencies of Munks, the Examiner has combined Munks with Kobayashi, Mooradian, and Camparo. In particular, Kobayashi is relied upon for teaching a DBR laser using top and bottom electrodes. Mooradian is relied upon for teaching an optically pumped laser system, and Camparo is relied upon as teaching a controller that supplies a control signal to the pump laser to adjust the intensity of the pump laser. However, applicant respectfully asserts that, none of the cited art modifies the direct

control system architecture that is taught by Munks and as explained below is inapposite to the claimed invention. Neither Kobayashi nor Mooradian teach a feedback control system at all, and Camparo, which does teach a laser control system, also teaches a direct control system architecture.

In particular, in Camparo the controller 36 is provided with measurements of the laser energy emitted from pump laser 12 and received by photo-detector 35. The photo-detector 35 converts the received laser energy and converts this laser energy into an electrical signal. This electrical signal from photo-detector 35 is directly provided as a measurement signal to the controller 36 that in turn provides control signals to the pump laser 12. See Camparo, Fig. 1 and col. 5, lines 8-19. Thus Camparo, like Munks, also teaches a control system in which the feedback loop is used to directly control the laser that is emitting the laser signal that is being measured. Applicant asserts therefore that Munks and Camparo both teach a direct control strategy that when combined with Mooradian and Kobayashi would result in a system that would either: 1) measure the laser signal and control the optically pumped tuned laser directly; or 2) measure the pump laser signal and control the pump laser directly. That is, the combination of cited art would form a pumped laser system having a control system that measures a signal characteristic of the pump laser signal and adjusts the pump laser according to some criteria to maintain the signal characteristic of the pump laser signal at a predetermined level.

Applicant has amended claim 1 to more clearly point out that the claimed invention is directed to an optically pumped tuned laser system. In particular, the claimed invention includes a pump laser that provides a pump laser signal having a measurable signal characteristic. The pump laser signal is optically coupled to an optically-pumped tunable laser that in turn provides an output laser signal having a wavelength. A wavelength-measuring module receives a portion

of the output laser signal, measures the wavelength of this signal, and provides an error signal that is indicative of the difference between the measured wavelength of the output laser signal and a desired wavelength. A control unit receives the error signal and provides a control signal to the pump laser to modify one or more electrooptical gain characteristics of the gain medium of the pump laser. Modifying the electrooptical gain characteristic of the pump laser modifies one or more signal characteristics of the pump laser signal, typically the intensity of the pump laser signal, and when coupled to the gain medium of the optically pumped tuned laser, modifies the wavelength of the output laser signal.

Accordingly, applicant respectfully asserts the combination of Munks and the cited prior art fails to teach or suggest an indirect control strategy as claimed in claim 1. In particular, the combination of cited prior art fails to teach a wavelength control system for an optically pumped tuned laser in which the measured variable is the wavelength of the laser signal emitted by the optically pumped tuned laser, and in which the measured wavelength is used by a feedback controller to provide a control signal to the pump laser to adjust a performance characteristic of the gain medium thereof and thereby change a signal characteristic of the pump laser signal.

Even if the Examiner finds that the combination of Munks and the other cited art teaches or suggests each and every limitation in claim 1, applicant respectfully submits that there would be no motivation to combine these references. One of the problems solved by the claimed invention was to overcome wavelength deviations in the laser signal due to vibrational problems. In an optically pumped laser, the vibrational problems may be caused by thermal noise. By contrast, in an electrically pumped laser, the vibrational problems may be due to thermal noise, shot noise in the injection current, or noise in the laser tuning voltage. Of the cited prior art only Camparo mentions noise in a laser signal as a problem, but then goes on to provide other

solutions for reducing the effect of shot noise by using optical filters in combination with the photo-detector. See Camparo, col. 6, lines 49-67. Although Camparo does discuss stabilized laser control systems, the laser controllers described therein are of a direct control architecture. See Camparo, col. 5 lines 8-19.

Thus, none of the cited prior art discusses the need to stabilize a laser from vibrational noise problems as discussed in the present application. Furthermore, neither of the cited prior art that discusses pump lasers, i.e., Mooradian and Camparo, even suggest the possibility that there may be advantages to controlling the pump laser instead of the tuned laser. While applicants realize that there is no requirement that the prior art provide the same reason as the applicant to make the claimed invention, see MPEP 2144, 8th Ed. pp.2100-127 to 2100-128, the art must provide at least some motivation to combine the references in the manner suggested by the Examiner.

In this instance, there does not appear to be any motivation to combine the prior art with the Camparo reference at all. The Camparo reference is directed toward a stabilized atomic clock and not toward a laser system. Although the atomic clock system described in Camparo includes a pair of separate individually stabilized lasers, there is little discussion regarding the laser elements other than the need for closed loop stabilization of them. In Camparo, the probe laser, one of the two stabilized lasers in the Camparo reference, is not used to provide pump energy. Camparo does include a pump laser, the other stabilized laser that is used to provide pumping energy to the Rubidium 85 atoms contained in a gaseous mixture that is used in the atomic clock. The Rubidium 85 atoms fluoresce and the resulting photons are used to optically pump the Rubidium 87 atoms that are also contained in the gaseous mixture. See Camparo, Fig. 1 and col. 4 lines 5-12. Camparo only teaches the optical pumping of a gaseous mixture of

atoms, and therefore, nowhere does Camparo teach or suggest the use of a pump laser to optically pump a semiconductor laser.

In addition, there is no mention in Camparo of any of the problems associated with lasers such as the vibrational problems associated with lasers that the present application identifies. The actual discussion of the laser control systems is perfunctory at best, explaining: "The controllers 36 and 38 may be of similar construction comprising respective mixers, integrators, and phase modulators, not shown. Those skilled in the art know how to design stabilization controller, such as, controllers 36 and 38." Camparo, col. 5, lines 14-18. Thus, there is no appreciation in Camparo of the problems identified and solved in the present invention.

In addition, the laser control system in Camparo does not use a wavelength measuring system that provides an error signal, rather Camparo teaches the use of a photo-detector that is sensitive at the pump laser wavelength and provides an output signal that is a direct conversion of the laser energy into electrical energy. See Camparo, col. 5 lines 1-3. Thus, for the control system in Camparo, there is no actual measurement of the wavelengths of the laser energy or comparing the measured wavelength to a target wavelength to determine the difference between the two wavelengths. Thus, the feedback signal that is used in Camparo is quite incompatible with the feedback signal used in Munks and therefore the control system in Camparo and the control system in Munks are not interchangeable or equivalent.

Accordingly, because of the different technical areas Munks and Camparo are in, the very different problems addressed by the two patents, the lack of any understanding of the problems solved by the claimed invention, and the incompatibility of the two control systems, the applicant asserts that there is no motivation to combine Camparo with any of the references cited by the Examiner.

The Examiner posits that the motivation to combine the references would have been to electrically isolate the optically-pumped tuned laser from the control circuit and that this would have been known to those skilled in the art. However, none of the cited prior art even mentions the need to electrically isolate a pumped laser from a feedback control system. The Munks laser is not electrically isolated from the laser controller and no mention is made of any need to electrically isolate the two elements. Even the Camparo reference, which is directed toward an atomic clock system and is arguably a system that is very sensitive to noise, does not electrically isolate either of the two laser sources, i.e., the pump laser 12 and the probe laser14, from the corresponding control system 36 and 38 respectively. Accordingly, the motivation provided by the Examiner would seem to border on hindsight rather than an actual finding of motivation in the art.

For the reasons stated above, the applicant respectfully submits that all of the cited art, either alone or in combination, fails to teach or suggest directly controlling the pump laser and thereby indirectly controlling the optically pumped laser to control the wavelength of the laser output signal. In addition, for the reasons stated above, the applicant respectfully submits that there would be no motivation to combine the art and in particular, no motivation to combine Camparo with any of the other cited art. Accordingly, applicant respectfully requests the reconsideration and allowance of claim 1. Claim 2 depends from claim 1 and is patentable for at least the same reasons as claim 1.

Independent Claims 5 and 6:

Claims 5 and 6 have been amended to include similar limitations as claim 1 and accordingly are allowable for substantially the same reasons set forth above with respect to claim 1. Applicant respectfully requests reconsideration and allowance of claims 5 and 6.

Conclusion

In view of the foregoing remarks and amendments, applicant respectfully submits that all present claims and the Application are in condition for allowance and such action is respectfully solicited.

If there are any questions or concerns regarding the amendments or these remarks, the Examiner is requested to telephone the undersigned at the telephone number listed below.

If any fees are due in connection with this filing, the Commissioner is hereby authorized to charge payment of the fees associated with this communication or credit any overpayment to Deposit Account No. 502246 (Ref: 13204CKUS02U).

Respectfully Submitted

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